

## International meeting on fungi provides wonderful science

When, at the third International Mycological Congress (IMC3) in Tokyo in 1983, the officers of the International Mycological Association (IMA) accepted the invitation from the Federal Republic of Germany to host the congress at Regensburg in 1990 (IMC4), they knew what they were doing. For central Europe, and more precisely Bavaria, the area in and around Regensburg in Germany, historically is the cradle of mycology. This is where the great pioneers collected and described mushrooms, toadstools and microfungi. Regensburg itself has a great history dating back to Roman times, still extant in remains of the Roman fortress of Castra Regina constructed by Emperor Marcus Aurelius in 179 AD. Following a visit to Regensburg in 1786, Goethe wrote: 'Regensburg's situation is enchanting'. The year 1990 is significant in that it marks the 200th anniversary of the death of Jacob Christian Schaeffer, the most distinguished mycologist at the time of Linnaeus, and also of the founding of the Regensburg Botanical Society, the oldest society of its kind still in existence. The events in eastern Europe earlier in the year, paving the way for the unification of Germany, and the free flow of people from eastern to western Europe, seem fortuitous, but surely contributed to making the congress a unique and remarkable event, a meeting of minds unusual for its universality and enthusiasm since the last War. The official number of 1664 participants from 59 countries is a measure of the status of our science: it included over a hundred from eastern Europe and about 40 from Israel, Iraq and Iran, despite the Gulf crisis.

The congress was held from 28 August to 3 September in the University of Regensburg, which is itself young. If, unlike Regensburg itself with its beautiful buildings and pretty streets, the univer-

sity buildings were dull and without character, this was offset by the facility they gave for holding most events and the concurrent sessions all under one roof—a welcome arrangement.

The congress programme, arranged in seven sections (systematics and evolution, morphology and ultrastructure, ecology, genetics and physiology, biotechnology and applied mycology, pathology, and general topics), included presentations on almost all areas of mycology in the broad sense—though

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one would have liked more prominence for medical mycology—in symposia, posters and general lectures. The inevitability of having to miss lectures of interest, which goes with concurrency of sessions, has become an unavoidable adjunct of such congresses, and, as though this were not enough, the Regensburg congress programme was so crowded as to confront participants with the choice of a lunch or a general lecture and many had naturally to

forgo one or the other! It is impossible to deal with everything that was offered at the congress. I only mention some highlights and record my general impressions of the congress.

The opening lecture by A. Bresinsky (Germany) was titled 'Science in Regensburg: Jacob Christian Schaeffer and the Botanical Society'. From Schaeffer to the present day the Regensburg legacy was beautifully traced, as it were, to impress even the hardest among us who may have no respect for the past; the main theme, the glory of Regensburg botany and mycology, a glory that is a continuum culminating in later works of specialists like Anton de Bary, Andreas Allescher, Franz von Hoehnel, von Martius, Alexander Braun, Hans Burgell, Hans Kniep and Heinrich Wieland, to mention a few. This was a great presentation befitting a great occasion and carried the much-needed reminder that modern science is built on the discoveries of pioneers and that one can still learn from, or at least be inspired by, the work of the pioneers. The thunderous applause that Bresinsky's lecture evoked was spontaneous and, I think, an acceptance that Regensburg had, and continues to have, respect for science—science in its wholeness and oneness, for there is even a Kepler legacy and Kepler is commemorated by a monument in the heart of the town.

Bresinsky's lecture was followed by Karl Esser's (Germany) on molecular aspects of ageing. Esser's concern with ageing is understandable (notwithstanding the participation in the congress of several senior mycologists, notably A. F. M. Reijnders (90) from the Netherlands and C. T. Ingold (85) from the United Kingdom, both of whom are wonderfully active). Esser's data come from a study of ageing in a filamentous ascomycetous fungus (*Podospira anserina*), considered to be a model system for such study.



Esser postulates that the onset of senescence in *Podospora* depends on nuclear genes. The plasmid responsible remains integrated in the mitochondrial genome in juvenile cells but gets released and transforms the cells to senescence. On release the plasmid can propagate autonomously. Though there are thousands of fungi occurring in all kinds of situations and habitats and doing different things, we still do not have answers to many questions concerning aspects of their functioning, certainly not at the molecular level. There is little doubt that studies in this area will receive more attention in the future.

There was, of course, no focal theme for the congress in any special area, but the most impressive picture that emerged, as far as the present writer is concerned, is in the areas of fungal biology, fungal interactions, fungal chemistry and biochemistry, and molecular and taxonomic aspects on which these impinge.

The smut-host interaction is one among many interactions about which little is known. A. M. Nagler's (Germany) analysis of interaction types from an ultrastructural study shows how useful such studies can be not only in deciphering the post-infection behaviour *in vivo* but also in using such information to evolve a better taxonomy of smut fungi, which have representatives as varied as *Entyloma*, *Ustilago* and *Tilletia*. Another interesting interaction reported at the congress came from the work of K. Sivasithamparam (Australia) and his colleagues on the effect of association of the nematode *Meloidogyne arenaria* and the fungus *Fusarium oxysporum* on subterranean clover. Where infection and colonization of the clover root was concerned, it was nearly always one or the other, the fungus or the nematode. The primary colonizer, be it the nematode or the fungus, did not permit colonization by the other. There should be other examples of such interaction, but what factors operate in primary colonization?

The beauty and the complexity of fungal interactions, such as those seen in mycorrhiza and mycorrhizal symbioses, were fully reinforced in several presentations. D. J. Read (UK) spoke quite convincingly about the specialized nutritional and non-nutritional attributes of the three major categories of mycorrhiza, the ericoid, the ecto- and the vesicular-

arbuscular, and the significance of these, in turn, on the characteristic way in which mycorrhiza are found to occur in particular ecosystems. The logic, stressed by Read, of a relationship of the nature and kind of mycorrhizal association to the vegetational type and its boreal, temperate or tropical distribution seemed inescapable. The papers on anatomical studies of ectomycorrhizae by R. Agerer (Germany) and on characterization and identification of ectomycorrhizae, especially in situations where successions seem to occur, as in *Pinus patula*, by K. Natarajan (India) highlighted admirably the importance of such studies. The ever-increasing interest in mycorrhiza and in vesicular-arbuscular (VA) mycorrhizae in the tropics was reflected in several contributions. (Both in afforestation programmes and in the achievement of increased productivity of our agricultural crops, research in this area has immediate relevance.) Especially significant are the observations on sexual and asexual spores of VA mycorrhizal fungi presented by I. C. Tommerup (Australia), specifically on *Gigaspora decipiens*, in which teleomorphs develop mono- and bigametangially. Equally important are her findings and speculation concerning monogametangial and homothallic bigametangial teleomorphs. Studies on this interesting group have only begun and the fact that a whole session was devoted to discussion of anatomy and ultrastructure of the Endogonales precludes more exciting work in the future.

The emergence of fungal endophytes as a group of special significance was endorsed at the congress in a full session devoted to them. Apart from clavicipitaceous endophytes, which have been known for some time, several others are now known and work on these concerns not merely the nature of the 'asymptomatic' interaction but, equally important, their relevance in plant health and productivity (health and vitality of the crop) and public health (impact of infected material in the food chain or otherwise in diverse ways). With the limited knowledge we have of these, one may still speculate on the evolution of the host-endophyte symbiosis, as G. C. Carroll (USA) did at the session. As far as the host plant is concerned, there is always a cost-benefit ratio. Enhanced nutrient cycling and

enhanced competitive fitness are benefits, but the endophyte is maintained on carbon fixed by the plant and there would be episodes when the beautiful balance between the partners is disturbed and all goes awry for both plant and fungus. It is rather interesting that, in the case of clavicipitaceous fungi and their 'hosts', the highest level of carbon fixation occurs in infected plants compared to uninfected ones, and the level is apparently maintained, as, for example, in fescue. The taxonomic diversity of fungal endophytes and their widespread occurrence would suggest repeated convergent evolution. Indeed, the study of the precise nature of interaction in diverse host-endophyte systems would be both exciting and rewarding.

The homobasidiomycetes figured prominently in one context or other at the congress and there were many luminaries, including M. Moser (Austria), H. Kreisel (Germany), R. H. Petersen (USA), E. Parmasto (Estonian SSR), A. F. M. Reijnders (Netherlands), C. Bas (Netherlands) and L. Ryvarden (Norway), to highlight issues in systematics, floristics and evolution. The contributions on ectomycorrhizae already referred to brought this group further into focus. Paramorphological studies and, in particular, the immense progress in the area of fungal secondary metabolism (and, in turn, of chemotaxonomy) came into full view. W. Steglich (FRG) spoke with great feeling and interest about new secondary metabolites of basidiomycetous fungi, on which he has made significant contributions. The organic chemist is interested in pigments and active compounds and, while many compounds would be of interest anyhow, it is not always that one gets an 'active' compound—it all depends on what kind of activity we are looking for. Of such compounds Steglich mentioned several, such as strobilurin, which inhibits tumour cells, and strobilin and oudemansin, which have been shown to be antifungal. Secondary metabolites and metabolism should be the concern of not only chemists but also of mycologists, and the concern of the organizers of IMC4 in this was reflected in two full sessions devoted to this subject. D. Wink (Germany) gave a clear picture of how one would go about screening fungi for secondary metabolites, citing as an example of potential importance his



group's discovery of restrictin, which is reported to be an inhibitor of cholesterol biosynthesis. M. M. Dreyfuss (Switzerland) stressed the need to look for fungi carrying blueprints for metabolites. Referring to the frustration one experiences in the hunt for active metabolites (what he referred to as the 'Sandoz phenomenon'), he rightly pointed out that we should fully tap the diversity of fungi and cited fungal endophytes as a group with much potential, though eight years of screening such fungi has so far yielded only about a hundred different metabolites, including some new ones. We have to move on fast and far from here since the fungi in our culture collections are but a fraction of those that occur in our biosphere, and, held in captivity in an environmental milieu quite alien to many of them, these fungi are not what they are in 'nature'. There is so much to do and, in the coming decade, I expect this subject will receive the attention it urgently needs.

H. Faulstich's (Germany) general lecture on amatoxins and phallotoxins was not only topical and of general interest but was penetrating, absorbing and thorough in presenting the progress of our knowledge of these toxins. Beginning with the classic work of Wieland, also in Germany, the toxins of the deadly *Amanita phalloides* have not only been identified and characterized, but the biochemistry of the toxins and of the syndrome of poisoning have been fairly thoroughly investigated. Though protein conjugates of amatoxins are ten times more toxic than natural amatoxins, the fact that these can be used for raising amatoxin-specific antibodies now facilitates use of polyclonal antibodies for amanitin immunoassays. Indeed, a monoclonal antibody could be a potential antidote in the immunotherapy of human poisoning by *Amanita*. Another facet of interest in this work is the observation that amatoxin-epidermal growth factor (EGF) conjugates are cytotoxic *in vitro*, e.g. to carcinoma cells. There is no telling the new possibilities in medicine and health such work implies.

Perhaps one of the most exciting and animated and refreshingly well-presented papers at the congress was that of C. E. Bracker (USA). Bracker spoke to a packed and full house on 'The hyphal tip: a cell designed for growing, growing,

and growing, and . . .'. In describing the work on the hyphal tip, Bracker touched on several important questions that concern our understanding of hyphal growth, such as the content and role of apical vesicles, patterns and mechanics of cytoplasmic streaming and vesicle migration, the nature of Spitzenkörper, forces and mechanism involved in cell polarity, genetic and biochemical regulation of enzymes in cell-wall synthesis and extension, apical turgor, microstructure of the apical wall—all absorbingly interesting and pertinent. His description of organelle dynamics, apical growth rate and cell shape in fungi using video-enhanced microscopy was stimulating. These have helped postulation of a mathematical model aimed at correlating growth patterns in hyphal apices with the behaviour of a hypothetical vesicle supply centre located within the growth zone of the tip cell. The uniqueness of the fungal hypha was beautifully highlighted in what seemed to be a rededication to understanding the fungal hypha thoroughly in the spirit of Reginald Buller and Philip Gregory. The final paper in the session was as exciting as the first (Bracker's) and H. Whisler (USA) took the audience with him when he spoke on 'To sex or asex, that is the question for *Monoblepharis*'.

Chelation in biological systems is a subject now in the frontline of research and a significant area that is receiving increasing attention is the study of siderophores in fungi and their biological function. G. Winkelmann's (Germany) general lecture highlighted significant work on fungal siderophores. The three kinds of siderophores that are known—ferrichromes, coprogen and fusarinines—occur in a variety of fungal taxa, though there seems to be no correlation of their production with the taxonomic group to which the fungus belongs. Siderophores quite clearly function in iron solubilization, iron transport and iron storage. Lacking siderophores, a fungus hypha may be prevented from producing conidia; when conidia lose siderophores in low water activity, germination may be reduced. Not only siderophores and chelation but the importance of Fe and other heavy metals in fungal growth and metabolism needs further study.

Taxonomic and floristic studies of fungi continue to attract attention both in western and eastern Europe, in the

advanced countries and even in the developing countries where they are most needed. The *Flora Agaricina Neerlandica* (i.e. the flora of Agarics and Boletes of the Netherlands and adjacent areas), which will cover the great majority of agarics and boleti of western Europe, is an invaluable 10-volume work well near completion, as described by C. Bas. The sessions on lichen taxonomy and systematics; on the new systematics of the Ascomycetes, excluding the lichens; on yeasts; on heterobasidiomycetes; and on fungi imperfecti provided a forum to present recent advances. The increasing concern and interests of students in strengthening classical or traditional taxonomy from data derived from paramorphological approaches, ultrastructural studies, genetic and various chemical and biochemical parameters were reflected in a great many presentations, such as J. W. Kimbrough's (USA) contribution on septal structures and systematics of operculate Discomycetes, G. Deml's (Germany) on chemotaxonomy of smut fungi, J. Sugiyama's (Japan) on *Rhodospodium*, *Rhodotorula*, *et al.*, and C. P. Kurtzman's (USA) on phylogeny of ascomycetous yeasts from ribosomal-RNA sequence comparisons. There were two sessions devoted to chemotaxonomy.

Indeed, in a session devoted to definition and basis of arrangement of fungi also, these aspects were stressed. S. Bartnicki-Garcia (USA) circumscribed what in his view is a fungus—quite clearly a eukaryotic organism with the mycelial habit, the ability to produce a long branched tubular cell wall by apical growth, and the ability to acquire its nutrition by absorption of organic matter. To be sure, too, the fungi are polyphyletic and the cellulosic Oomycetes need to be grouped along with the chitinous fungi in one kingdom. Departing from the title of the talk in the programme, Bryce Kendrick (Canada) chose to speak in his inimitable way on the ideal classification of the fungi. The zoosporic fungi (excluding the Acrasiales, Myxomycetes, Labyrinthulales, etc.) would fit into the Promycota, and the Zygomycetes, Ascomycetes, Basidiomycetes and their anamorphs into the Eumycota. The contributions of G. E. Pfyffer (Switzerland) on the role of biochemistry for fungal arrangement (L, carbohydrates and proteins), of P. Blanz



(Germany) on the role of biochemistry for fungal arrangement (II, nucleic acids), and of D. McLaughlin (USA) on the role of ultrastructure and cell biology for fungal arrangement effectively underlined the contribution each of the approaches could make for a better taxonomy (something that eludes us, but yet we are after it all the time!). It would appear that certain cell-wall polysaccharides would give support to some traditionally circumscribed taxa, and polyols may be useful in settling the true status of certain taxa at the species level. The usefulness of ribosomal-RNA (rRNA) nucleotide sequences for unravelling phylogenetic relationships, especially, in the case of yeasts and related fungi, has also been demonstrated.

H. Kreisel's (Germany) general lecture on neoteny in fungal phylogeny dealt with a number of parameters, including life cycles, genetics, cell-wall chemistry, and, of course, morphology and dimorphism. The result was a beautiful but hypothetical picture of neoteny in fungi as seen by an expert known for his understanding of a range of taxa in the Mycota.

The exposition of phylogenetic problems in Basidiomycetes in relation to morphogenesis by A. F. M. Reijnders contained the wisdom from his long experience and familiarity with these fungi. The difficulties in the interpretation of what is primitive and what is derived would continue to exist in so far as taxa combined such characters. Expressing his disappointment with results of scanning and transmission electron microscopic research on spore-wall structure, Reijnders underlined the importance of biochemical and genetic parameters. Not merely ontogeny *per se*, but the biochemistry and genetics of morphogenesis and ontogeny need scrutiny. The need to study fungal hyphae, morphogenesis and development were also highlighted, in a different context, by J. G. H. Wessels (Netherlands) in his interesting general lecture. Reijnder's lecture was followed by one by C. T. Ingold (UK). (Given a bare 15 minutes, Ingold gave a masterly and perfect presentation in just 15 minutes, not less, not more!) The subject? One close to his heart, and close to his art—'The basidial gun and the perennial polypore'. Beginning where Buller had left the question, Ingold notes the need to modify Buller's

original picture of the process. It now turns out that the mature ballistospore is completely walled off from the sterigma, its tip serving only as a launching platform. Also, the Buller drop is not exuded but formed by condensation, and a blob is produced on the adaxial surface of the spore at the same time as the Buller drop develops.

All this is wonderful. And yet, there is no substitute for good taxonomy done in the traditional way, which currently can be augmented by high-resolution microscopy and what not. It was therefore good to see some excellent work aimed at monographing taxa. Notable examples include the presentations by K. Vanky (Germany) on Ustilaginales on Polygonaceae, by J. F. Hennen (USA) on the genus *Ravenelia* in the Americas, by J. E. M. Mordue (UK) on *Ravenelia* in Asia and Africa: taxonomic and phylogenetic considerations, by S. G. Vanev (Bulgaria) on taxonomic revision of the genus *Discosia* Lib., by P. F. Cannon (UK) on members of the Phyllachoraceae (Ascomycetes) parasitizing the Leguminosae, and by M. D. Nagarkar (India) on the lichen genus *Thelotrema* in Asia. The discussions of taxonomic problems of the *Ramularia/Cercospora* complex by U. Braun (Germany), of the need for a better appraisal of percurrent conidiogenesis in imperfect fungi by C. J. K. Wang (USA), and of variations in synnema structure in the Stilbellaceae in relation to taxonomy by K. A. Seifert (Canada) and G. Okada (Japan) reflect the continuing interest in imperfect fungi. Both Okada and Braun (younger scientists) gave a good account of what they were concerned with, but discussion was minimal and, I am sure, there was silent adulation. When all speakers turn up, and there is a crowded programme, as here, what else can happen?

The Ascos received their share of attention. Both R. P. Korf (USA) and J. D. Rogers (USA) claimed our close attention, the former by his impeccable treatment of the taxonomy of inoperculate discomycetes at the family level, and the latter by his valuable reflections on *Xylaria* with emphasis on tropical taxa. W.-Y. Zhuang (China) very competently surveyed the tropical elements in our knowledge of inoperculate discomycetes. The interest in tropical fungi

was clear from the presentations by participants from many countries, and, considering the diversity and richness of the mycoflora, exploration of the Indian mycoflora is still scanty.

Lichens were very much a part of the congress as before. The president of the congress, J. Poelt (Germany), delivered an erudite lecture on analogy and homology in the evolution of lichens. Apart from a session on lichen taxonomy and systematics, there was one on lichenicolous and fungicolous fungi. Work on this has perhaps just begun and the returns a study would give may well be imagined from the presentation, for example, on fungicolous and lichenicolous Hypocreales by R. Lowen (USA), who (jointly with C. T. Rogerson and C. J. Samules) surveyed this group.

Finally, there were some excellent 'posters'; also: videodisc presentations and films; special discussion groups (Nomenclature, *Fusarium*, *Phytophthora*, ...); workshops; exhibitions, on the history of botany in Regensburg and the Botanical Society, on the history of mycology in Bavaria, on paintings of higher fungi, and on fungi on stamps. This was enough and more. There was nothing to complain about, except, perhaps, of 'saturation'.

Between the last congress and the present one, mycology lost several of its stalwarts, notably, C. J. Alexopoulos (first president of the IMA, and later honorary president), J. N. Couch, J. A. Nannfeldt, Kenneth B. Raper, Lindsay Olive, Philip H. Gregory, S. D. Garrett (see obituary of Garrett, *Curr. Sci.*, 1990, 59, 755), E. S. Luttrell, J. A. von Arx (former treasurer, IMA). Their great work lives on. There was at the congress the president (C. T. Ingold) of the first congress held at Exeter in England in 1971, and myself, a past president (1977-83) of the IMA. (There was a special word of welcome from J. Webster, current president of the IMA.) There were many young mycologists from all over the world at the congress and there was joy not only in meeting old friends but in making new friendships from distant places where beautiful fungi abound. And there is no doubt that the quality of science was wonderful.

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## Verdict in journal cost survey row

A German court has given verdict (*Science*, 1990, 250, 906) in the court battle between Gordon and Breach Science Publishers and the American Institute of Physics, American Physical Society and the American Mathematical Society over the publication of survey articles on the cost of journals (see *Curr. Sci.*, 1990, 59, 584). Gordon and Breach and the American Physical Society and the American Institute of Physics have made conflicting claims about the German court's verdict. Gordon and Breach has claimed in a press release that the German civil court has agreed with it (G and B) that 'the surveys in which the prices of G and B journals appear to be extremely high were "false and misleading" and amounted to unfair competition under German Law'.

However, the court dismissed the appeal and opined that the surveys were directed at the US market and their distribution in Germany was limited. Though not fully satisfied with this verdict, Gordon and Breach is said to be 'heartened' that the court had agreed that the survey methodology was flawed.

Interestingly, the American Institute of Physics and the American Physical Society have viewed the court decision in a different light and not as a victory for Gordon and Breach. Henry Barschall, the author of the survey article published in the July 1988 issue of *Physics Today* (a journal of the American Institute of Physics), who is said to have attended the court proceedings, says, 'The court did not determine that the price survey was illegal advertising and it certainly

did not find that my work was false and misleading.'

In the absence of the original documents (court's ruling) at this stage one is unable to come to a definite conclusion. The verdict of the French and Swiss courts where the same case has been filed is not yet known.

Whatever be the final verdict on the case, the prices of journals are still increasing and libraries all over the world are facing difficulties coping with budget cuts and the rising cost of journals. Any reasonable indicators of increase in cost of journals would always be helpful not only to librarians but also to scientists recommending journals to their libraries.

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## Panjab University suspends Gupta

Since the publication of a damning report based on evaluation of papers published by V. J. Gupta between 1969 and 1988 in the *Journal of the Geological Society of India* (reported in these columns, *Curr. Sci.*, 1991, 60, 138), Panjab University's vice-chancellor R. P. Bambah has moved to suspend Gupta from his posts in the university.

The report of the Geological Society of India, and another, equally damning one, by the New Delhi-based Society for Scientific Values, an independent body of scientists concerned with ethics and morality in science, were both available to Bambah earlier, but action against Gupta was pending amid reports that a high court judge was to go into the

entire affair.

The university's action now brings to an end a two-year-old controversy following the allegations against Gupta by John Talent, an Australian palaeontologist (see *Nature*, 1989, 338, 613, and 1990, 343, 305; see also *Curr. Sci.*, 1990, 59, 13, 244 and 441).